Thus the recovery curve can be constructed by making a tracing of the drift curve, inverting it and shifting it along the time axis by an amount t_0. The algebraic sum of the ordinates of these two curves forms the desired curve for z as a function of t'. This method has been applied with fair success to data furnished by Dr. C. E. Van Orstrand for the slow stretch in a steel tape over a period of four months, when suspended under tension. The greatest difference between the calculated and observed after-effect at any time during this long period was less than 9 per cent of the initial after-effect.

A similar check on equation (19) should be possible by reference to Michelson's data for torsion. His recovery curve formula may be written[6]

$$z = KRe^{-\alpha\sqrt{t'}}\ (1 - e^{-\alpha\sqrt{t_0}}) \qquad (20)$$

Substitution from (9) into (19) gives

$$z = KRe^{-\alpha\sqrt{t'}}\ [1 - e^{-\alpha(\sqrt{t_0 + t'} - \sqrt{t'})}] \qquad (21)$$

This, for small values of t', reduces to Michelson's experimental formula (20), but for large values it diverges. It is not possible to make an exact test of equation (19) without reference to the original observations, which were not given in the paper above cited.

These examples may suffice to make clear the general purpose of the superposition theory. It is not a molecular theory, neither does it aim to deduce a *priori* anything about the form of the drift function. It presupposes the availability of just such data as Michelson's drift curve (9) and then proceeds to develop the necessary interconnections between the drift and the remaining irreversible effects.

BOTANY. *Notes on the genus* Swartzia *in Panama and Guatemala.*[1]

HENRY PITTIER.

The genus *Swartzia* of the Caesalpiniaceae contains a large number of species, many of which are closely related, and the genus as a whole is badly in need of revision. In the present paper an attempt is made to systematize the representatives of the genus now known from Panama. A little known species of the genus from Guatemala is also described.

[6] *Op. cit.* See also Journ. Geol. **28:** —. 1920.

[1] Received February 11, 1921.

1. REVISION OF THE PANAMA SPECIES

Legume broad, long, and flat; racemes many-flowered, elongate; leaves pinnate, 5-foliolate. (PLATYPODA.) 1. *S. panamensis.*

Legume cylindrical, short; racemes 2- to 5-flowered; leaves mostly 1- or 3-foliolate, rarely 5-foliolate. (STRONGYLOPODA.)

Leaves unifoliolate. Petiole narrowly alate or scutellate at the apex; petal about 4 cm. in diameter. 2. *S. simplex.*

Leaves mostly 3-foliolate, sometimes 1- or 5-foliolate.

Stamens 20 or fewer, not conspicuously unequal. Flowers small, the petal hardly longer than the calyx. 3. *S. arborescens.*

Stamens numerous, conspicuously dimorphous, the longer ones 10 to 20, the smaller ones numerous.

Leaflets not over 10 cm. long, lanceolate, the petioles rather broadly winged. 4. *S. trifolia.*

Leaflets usually larger, ovate, the petioles rather narrowly winged.

Petal suborbicular, about 2 cm. in diameter. 5. *S. myrtifolia.*

Petal ovate-cordiform, about 2.5 cm. long and 3 cm. broad. 6. *S. darienensis.*

1. **Swartzia panamensis** Benth. in Mart. Fl. Bras. **15**[2]: 38. 1870.

Deciduous (?) tree, 6 to 20 meters high, with short ascending limbs and elongate crown, the trunk seldom over 40 cm. in diameter, often distorted, the bark grayish, smooth.

Leaves 5-foliolate, pubescent, glabrate, with lanceolate-acuminate silky-pubescent caducous stipules; petioles 9 to 13 cm. long, almost terete; petiolules articulate, 4 to 6 mm. long; blades elliptic or ovate-lanceolate, rather long and narrowly acuminate, 8 to 18 cm. long, 3 to 6 cm. broad, dark green above, pale green beneath, the venation sparse, impressed above, prominent beneath, the 9 to 11 primary veins alternate, arcuate, transversely anastomosing.

Racemes solitary in the defoliated axils of the preceding season or in the axils of new leaves, very long (20 to 40 cm.), pendent, many-flowered, the bracts awnlike, up to 10 mm. long, caducous; rachis and pedicels minutely pubescent, the former thick and subangular; pedicels reflexed, clavate, about 2 cm. long; calyx opening irregularly by 4 or 5 reflexed lobes about 1 cm. long. Petal creamy yellow, almost square (31 mm. long, 29 mm. broad), unguiculate, hastate and emarginate at the base, subquadrilobate, with irregular margin; claw narrow, about 6.5 mm. long. Stamens very numerous, the larger ones 6 to 10, erect, with thick filaments 12.5 mm. long, the remaining small ones with threadlike filaments 15 mm. long and smaller anthers, their cells more or less parted at the base. Ovary short, flattened, entirely smooth, long-stipitate, with a short, blunt, hardly bent style; stipe 6 mm. long, the ovary and style about 5 mm. long; ovules 8 or fewer.

Legume single, 20 to 30 cm. long, 8 to 10 cm. broad, coriaceous, apiculate, dehiscent, 4- to 8-seeded; pedicel thick, 2 cm. long; stipe 1.5 to 2 cm. long; seeds large, irregularly sublenticular-ovate, 7 to 8.5 cm. long, 6 cm. wide, and 1.5 cm. thick, exarillate, dark brown.

SPECIMENS EXAMINED:

PANAMA: Rocky slopes along Chagres River near Alhajuela, flowers and fruit, May 13, 1911, *Pittier* 3520. Along Trinidad River, Canal Zone, near sea level, flowers, July 20, 1911, *Pittier* 4019. Around Port Obaldia, San Blas Coast, flowers, September 2, 1911, *Pittier* 4324.

Also recorded by Seemann from San Juan de Chagres and Hacienda de Juan Lanas. Seemann describes the racemes as being in pairs, a character not shown by the recent specimens, though these agree in the main with Bentham's short diagnosis. These collections from the shady forests of the littoral plain around Port Obaldia have broader and less coriaceous leaflets than those from the high banks of the Trinidad River or the rocky slopes of the Chagres gorges. In the first locality, too, the tree assumes more frequently an erect, regular shape, with a straight trunk. It seems that only the basal flowers of each spike bear a pistil; this part was missing altogether on several of the specimens I had occasion to dissect, and, so far as my experience goes, the pods invariably grow out of the 5 flowers nearest to the base of the raceme. Usually there is only one pod to each raceme, but two on the same peduncle are not uncommon. Completely developed seeds are seldom found. The trees on the Chagres River bore only new, incompletely developed leaves, although anthesis was rather advanced and even fully grown pods were present. These facts would indicate a deciduous species, the only one reported so far in this heterogeneous and not well defined genus.

2. **Swartzia simplex** Spreng. Syst. Veg. **2:** 567. 1825.

Small tree, 3 to 10 meters high, the trunk 10 to 15 cm. in diameter, straight or distorted, with smooth grayish bark, the branching sparse and divaricate.

Leaves unifoliolate, quite glabrous, more or less coriaceous, nitidulous, the primary veins numerous and subparallel; stipules setaceous, 5 to 8 mm. long, caducous; petiole 3 to 15 mm. long, terete and auriculate at the apex when very short, marginate and distinctly articulate at the apex when longest; blades ovate-oblong, rounded or subcuneate at the base, shortly obtuse-acuminate at the apex, 4 to 20 cm. long, 2 to 7 cm. broad, the venation prominent on both sides.

Inflorescences racemose, 2- to 6-flowered, axillary or terminal, 4 to 10 cm. long, the rachis glabrous; pedicels erect, 5 to 20 mm. long, obclavate; buds globose, 7 to 10 mm. in diameter; calyx opening by 4 irregular lobes; petal orbicular, about 4 cm. in diameter, pale yellow; long stamens 8 to 12, the anthers elongate-oblong; short stamens numerous, the anthers also smaller; ovary long-stipitate, quite glabrous, arcuate, 10- to 12-ovulate, the style arcuate and subulate.

Legume oblique-oblong, terete, up to 4 cm. long, 1.5 cm. in diameter, usually 1- or 2-seeded, in the latter case hardly contracted between the seeds.

TYPE LOCALITY: Trinidad.

SPECIMENS EXAMINED:

PANAMA: Chagres, *Fendler* 327. Agua Clara, Canal Zone, along Rio Trinidad, fruit, June 20, 1911, *Pittier* 3984. Culebra, Canal Zone, flowers, January 6, 1911, *Pittier* 2256. Penonomé and vicinity, fruit, March, 1908, *Williams* 396. Marraganti, South Darién, fruit, April 5, 1908, *Williams* 995.

3. **Swartzia arborescens** (Aubl.) Pittier.

Possira arborescens Aubl. Pl. Guian. **2:** 934. *pl. 355.* 1775[2].

Tree, 6 to 10 meters high, the branchlets glabrous or pubescent.

Leaves glabrous, 3-foliolate or sometimes 1-foliolate; stipules setaceous;

[2] For full synonymy see Fl. Bras. **15**[2]: 22. 1870.

rachis, including petiolar part, 1 to 4 cm. long, narrowly winged and auriculate at least under the terminal leaflet; leaflet blades ovate or ovate-elliptic, rounded or cuneate at the base, obtusely short-acuminate, subcoriaceous, lustrous, the terminal leaflet 5 to 10 cm. long, the primary veins numerous, parallel, and conspicuous.

Racemes axillary or terminal, the short slender glabrous peduncles with 2 to 4 flowers; pedicels filiform, 1 to 1.5 cm. long; bracts small, setaceous; bracteoles very small or none; buds quite glabrous, subglobose, hardly 4 mm. in diameter; petal orbicular, unguiculate, a little longer than the calyx; stamens 18 to 20, almost all equal, twice longer than the calyx, the anthers ovate; ovary stipitate, narrow, glabrous, 5- or 6-ovulate, attenuate to a short style, the stipe a little shorter than the calyx.

Legume short-stipitate, obliquely ovoid, long-acuminate, 4 to 5 cm. long, thick and carnose; seed oblique-ovoid, the aril lacerate, the raphe very prominent.

TYPE LOCALITY: Near the source of the Galibi River, French Guiana.

This species was collected on Tobago Island by Seemann (no. 1687), but I have seen no specimens of it.

4. **Swartzia trifolia** Pittier, sp. nov.

Small tree, 4 to 5 meters high, the trunk 8 to 12 cm. in diameter, the branchlets, leaves, and inflorescences entirely glabrous, the bark dark red and smooth.

Leaves usually 3-foliolate, seldom 5-foliolate, coriaceous; stipules setaceous, stiff, about 4 mm. long; rachis 2 to 5 cm. long, terete, winged-auriculate, the wings broader at the auricles; leaflets subsessile, the blades lanceolate, more or less oblique and rounded at the base, obtusely short-acuminate at the apex, the lateral ones 4.5 to 7 cm. long, 2 to 2.5 cm. broad, the terminal one 5.5 to 9 cm. long, 2 to 3.5 cm. broad, the primary veins about 16, anastomosing along the margin, the venation conspicuous on both sides.

Flowers not known.

Fruiting pedicel about 1 cm. long; stipe 8 mm. long; fruit glabrous, 1-seeded, ovoid, acuminate, 3.5 cm. long, 1.5 cm. broad between the sutures; seed ovoid-subreniform, 2.5 cm. long, brown and lustrous.

Type in the U. S. National Herbarium, no. 677726, collected on the savanna of La Tortuga, between El Boquete and Caldera, Panama, at an altitude of about 400 meters, in fruit, March 21, 1911, by H. Pittier (no. 3343).

This species is so well characterized by its peculiarly shaped leaves and narrow leaflets that even in the absence of the flowers I do not hesitate to describe it as new.

5. **Swartzia myrtifolia** J. E. Sm. in Rees' Cycl. **34:** *Swartzia* no. 5. 1819.

Small tree, the slender branchlets as well as the leaves and inflorescences glabrous or slightly pubescent.

Leaves 3-foliolate or sometimes 1-foliolate; stipules subulate, 3 to 4 mm. long; rachis slender, marginate and more or less distinctly auriculate below the insertion of the leaflets, 2.5 to 5 cm. long; leaflets subsessile, the blades ovate or ovate-oblong, rounded or cuneate at the base, obtusely short-acuminate at the apex, subcoriaceous, nitidulous, the primary veins numerous and prominent on both sides; lateral leaflets 6.5 to 8 cm. long, 3 to 4 cm. broad; terminal leaflet 6.5 to 14.5 cm. long, 5 to 7 cm. broad.

Racemes axillary or terminal, 2- to 5-flowered, about equaling the petioles; bracts small, setaceous; bractlets minute or none; peduncles short; pedicels slender, 1 to 2 cm. long; buds globose, 6.5 mm. in diameter; segments of the calyx 4, reflexed; petal yellow, orbicular, about 2 cm. in diameter; larger stamens 12 to 18, the anthers oblong; smaller stamens numerous, the anthers half shorter than those of the larger ones; ovary glabrous, narrow, recurved, long-stipitate, 8-to 10-ovulate, the style much shorter.

Legume nearly 2.5 cm. long, obliquely ovoid-oblong, short-acuminate.

TYPE LOCALITY: West Indies.

SPECIMENS EXAMINED:

PANAMA: Obispe Falls, Canal Zone, *Hayes*. Pinogana, South Darién, in forest, flowers, June 21, 1914, *Pittier* 6676.

6. **Swartzia darienensis** Pittier, sp. nov.

Small spreading tree, entirely glabrous, 6 to 8 meters high, with short trunk and pendent branches, the bark smooth, grayish.

Leaves 1- or 3-foliolate, membranous; stipules linear, 4 to 6 mm. long, caducous; petioles of the 1-foliolate leaves 5 to 7 mm. long, articulate and provided at the tip with 2 stiff acute auricles; rachis of the 3-foliolate leaves 3 to 6 cm. long, canaliculate, marginate, with acute auricles at the insertion of the leaflets; leaflets petiolulate, ovate-elliptic or broadly lanceolate, rounded or obtusely pointed at tip, the lateral ones 7 to 10 cm. long, 3 to 4 cm. broad, the terminal one and the blade of the 1-foliolate leaves 12 to 16 cm. long, 5 to 6 cm. broad; petiolules 4 mm. long; veins very thin, almost parallel, delicately reticulate-anastomosing.

Racemes axillary or terminal, often geminate, 3- to 5-flowered; bracts and bractlets linear, minutely pubescent, caducous; rachis 1.5 to 7 cm. long; pedicels 5 to 10 mm. long, clavate, pubescent; segments of the calyx 4, irregular, about 1 cm. long; petal pale yellow, irregularly ovate-cordiform, emarginate at the base, about 2.5 cm. long (including the claw, this 5 mm. long) and 3 cm. broad; larger stamens 4 to 9, the smaller ones very numerous, the anthers slightly larger in the former but all alike and broadly ovate or orbicular, with a dark connective; pistil incurved; ovary long-stipitate, 8-ovulate; style a little shorter than the ovary, capitellate.

Legume not known.

Type in the U. S. National Herbarium, no. 678872, collected on the rocky slope of Mamei Hill, near Gorgona, Canal Zone, Panama, July 6, 1911, by H. Pittier (no. 3800).

There is certainly a great deal of confusion as to the segregation of the several very nearly related forms of *Swartzia* in Panama, and the difficulty of separating them is increased by the vagueness of the descriptions and the lack of material. The species just described belongs without doubt to the polymorphous group of *S. myrtifolia*, but it seems not to agree with the description of any of the species published.

2. A LITTLE KNOWN SPECIES FROM GUATEMALA

Swartzia guatemalensis (Donn. Sm.) Pittier.

Swartzia myrtifolia var. *guatemalensis* Donn. Sm. Bot. Gaz. **33**: 251. 1902.

Section *Pteropoda*. Small tree, the branches slender, glabrous or minutely appressed-pubescent.

Leaves 3-foliolate or often reduced to the terminal blade, glabrous or more or less appressed-pubescent; stipules subulate or linear, minutely pubescent; petioles 1.5 cm. long in the simple leaves, 2.5 to 4 cm. in the compound leaves, glabrous, broadly alate, the wings up to 7 mm. broad, acute or rounded below the insertion of the leaflets; leaflets short-petiolulate, ovate-lanceolate, rounded at the base, obtusely long-acuminate, the main primary veins (of the terminal leaflets) 11 to 14, anastomosing along the margin, prominent on both sides, the intermediate veins numerous and parallel; lateral leaflets 3.5 to 9 cm. long, 1.5 to 4 cm. broad; terminal and single leaflets 8 to 16 cm. long, 3.5 to 6 cm. wide.

Inflorescences 2- to 5-flowered, axillary or terminal, the rachis slender, sparsely appressed-pubescent; pedicels subfiliform, 12 to 15 mm. long; buds subglobose or broadly ovoid, glabrous, about 9 mm. long; calyx opening by 3 irregular segments, almost 10 mm. long; petal short-unguiculate, broadly ovate, 16 mm. long, 22 mm. broad; longer stamens 8, the anthers elongate, recurved; smaller stamens numerous and short; ovary long-stipitate (the stipe 10 to 14 mm. long), 6- to 8-ovulate, glabrous, 6 to 8 mm. long, the style straight, subulate, 5 to 6 mm. long.

Legume not known.

Type collected by von Tuerckheim at Cubiquiltz, Alta Verapaz, Guatemala, in flower, May, 1901 (J. D. Smith, no. 7839).

This plant, described by Captain John Donnell Smith as a variety of *Swartzia myrtifolia*, differs from that species in several important particulars, such as the disparity between the lateral and terminal leaflets, the conspicuousness of the main primary veins, the long acumen of the blades, the broad wing of the petiole, the 3-laciniate calyx, the shape of the petal, the 8 long stamens (instead of 12 to 18), and the long-stipitate ovary. These characters are sufficient to justify specific rank for this interesting member of the Guatemalan flora.

OCEANOGRAPHY.—*Practical application of the electrical conductivity method of measuring sea water salinity.*[1] A. L. THURAS. (Communicated by S. W. STRATTON, Bureau of Standards.)

Heretofore the only reliable method of measuring the total salt content of sea water has been by chemically titrating for the amount of chlorine present. The relation of chlorine to the total salts being a constant, a measure of the salinity is thereby obtained. Salinity is defined as the number of grams of total salts in 1000 grams of sea water. The titration method, being a laboratory method, requires that the samples after collection be stored in suitable bottles until they can be tested on shore. The disadvantages of such a method are: the loss or breakage of samples, possible errors from evaporation and handling, and the great undesirability of not knowing the physical properties of the waters while they are being investigated.

[1] Received January 31, 1921.